INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR
Mid-Spring Semester 2018-19

Date of Examination : 22nd February 2019 Session (FN/AN) FN
Duration: 2 hrs Total Points: 100 Department: E & ECE
Subject No. : EC21006 Subject Name : Electromagnetic Engineering

INSTRUCTIONS: Answer **all** the questions. Answer all parts of a question in the **same** place. Start each question from a **new** page. Make appropriate **assumptions** wherever necessary.

1. (a) Derive with proper justifications the expression for magnetic energy density for a linear medium.

(b) Consider a two wire transmission line of radius a, separated by a distance d (where d » a). The wire has relative permeability μ_1 and conductivity σ_1. The medium between the wire has relative permittivity ϵ_2, relative permeability μ_2 and conductivity σ_2. Using the result in (a) derive the total inductance per unit length of the transmission line.

(c) Derive the capacitance per unit length and the series and shunt resistance per unit length of (b).

[5+10+15]

2. (a) From the formal definition, derive the gradient, divergence and curl in spherical coordinates using spherical geometry.

(b) A grounded perfectly conducting sphere of radius 1m, is placed in a constant electric field of 1V/m along z-direction. Solve the BVP to determine the surface charge density on the sphere.

(c) Using he concepts discussed in the context of (b) how would you approach the problem of calculating the capacitance of the perfectly conducting sphere split (infinitesimally small) at the middle, maintained at 1V in the upper hemisphere and -1V in the lower hemisphere.

[15+10+20]

3. Find all the components of the magnetic field everywhere (with necessary justifications and assumptions) and the total inductance for a toroid of circular cross-section area A. The centre of the cross-section of the toroid is located at a radius R from the axis of the toroid. The no. of circular turns per unit length of the toroid is n.

[25]